Exchange Market Pressure in Australia

Abstract

This paper measures the exchange market pressure (*EMP*) on the Australian dollar over the post-float period using the model-dependent approach proposed by Weymark (1995, 1998) and the model-independent approach developed by Eichengreen, Rose and Wyplosz (1996). Although there are some concerns over the estimation of the model-dependent index, the resulting *EMP* indices both appear to provide relatively plausible descriptions of the pressure on the Australian dollar. The role of foreign exchange intervention is examined through the construction of degree of intervention (*DI*) indices. The results reveal that intervention by the Reserve Bank of Australia contributed to the large depreciation of the Australian dollar between 1997 and 2001.

Key words: exchange rate, exchange market pressure, foreign exchange intervention
JEL Classification: C22, F31, G15

Exchange Market Pressure in Australia:

1 Introduction

Since the collapse of the Bretton Woods system in the early 1970s, most industrialised economies have moved towards a managed floating exchange rate regime - allowing some exchange rate flexibility but often intervening in the foreign exchange market to influence the path of the exchange rate. Recent studies have argued that, under a managed floating regime, monetary authorities should focus on the pressure on the exchange rate, rather than changes in exchange rates and foreign exchange reserves alone (Tanner, 2001). This has led to the development of a large number of different measures of the magnitude of exchange market pressure (*EMP*), some based on structural models of the economy (e.g. Weymark, 1995, 1997, 1998; and Spolander, 1999) and some model-independent (e.g. Eichengreen, Rose and Wyplosz, 1996; and Pentecost, Van-Hooydonk and Van-Poeck, 2001).

Many of the measures of *EMP* based on structural models have been generated using a methodology proposed in Weymark (1995, 1998) that stands independently of the structural model employed. This paper provides an application of Weymark's methodology to the Australian case since the float of the Australian dollar using the small open-economy model outlined in Spolander (1999). It also provides an application of the model-independent approach developed by Eichengreen *et al* (1996). The resulting *EMP* indices are then examined to determine if they provide plausible descriptions of the pressure on the Australian dollar during the post-float period. As such, this paper contributes to the *EMP* literature by examining how well two existing methodologies perform when applied to another situation. The role of foreign exchange intervention by the Reserve Bank of Australia (RBA) is then evaluated by calculating degree of intervention (*DI*) indices, as described in Weymark (1995, 1998). The remainder of the paper is comprised of five main sections. Section 2 provides a brief overview of the literature. Section 3 outlines the theoretical measures of *EMP* and *DI*. Section 4 describes the data and section 5 details the estimation results. Section 6 contains some concluding remarks.

2 Background

The term *exchange market pressure* has been widely used in the intervention literature to describe movements in two key external sector variables - holdings of international reserves and the nominal exchange rate. One of the earliest studies to examine *EMP* by Girton and Roper (GR) (1977), used a monetary model to explain exchange rate movements, and defined *EMP* as the 'volume of intervention that is required to achieve any desired exchange rate'. Since the development of the GR model, many researchers have applied the model to a number of both developed and developing countries.[1] Modified versions of the GR model have also been applied to various countries. For example, Wohar and Lee (1992) applied a less restrictive version of the GR model, allowing for deviations from purchasing power parity (PPP) and incorporating foreign disturbances, to the Japanese case. Their results indicated that the less restrictive model performed better. This finding has been more recently supported by Pollard (1999) for Barbados, Guyana, Jamaica, and Trinidad and Tobago. Mah (1998) also highlighted the importance of incorporating dynamic specifications of some of the independent variables in the GR model.

Roper and Turnovsky (1980) and Turnovsky (1985) introduced the idea of using a small open-economy model in constructing an *EMP* formula. In a seminal contribution, Weymark (1995, 1998) provided a general methodology for calculating *EMP* that was model independent, under which the approaches of Girton and Roper (1977) and Roper and Turnovsky (1980) could be viewed as special cases. Weymark also proposed a model-independent definition of *EMP* as:

> *'The exchange rate change that would have been required to remove the excess demand for the currency in the absence of exchange market intervention, given the expectations generated by the exchange rate policy actually implemented'.*

Weymark (1995, 1997) applied her methodology to various simple open-economy models, and used summary statistics from actual changes in the exchange rate and foreign exchange reserves held by the central bank to calculate measures of *EMP*. Spolander (1999) extended the simple model in Weymark (1995) to incorporate a monetary policy reaction function and the sterilisation of foreign exchange intervention, thereby constructing a more realistic model of the economy.

Eichengreen, Rose and Wyplosz (1996) argued that dependency on a particular model was an undesirable feature for an *EMP* index. As an alternative, they proposed a measure of speculative pressure that is a linear combination of a relevant interest rate differential, the percentage change in the bilateral exchange rate and the percentage change in foreign exchange reserves. The weighting allocated to each of the three components is chosen so as to equalize their conditional volatilities. In a similar paper, Pentecost, Van-Hooydonk and Van-Poeck (2001) determined the weights using Principle Components Analysis. The *EMP* indices resulting from these approaches are model independent ‘because neither the components of the index nor the weighting scheme is derived from a structural model of the economy’ (Weymark, 1998).

3 Measures of Exchange Market Pressure

For log-linear, small open-economy models Weymark (1995, 1998) gave the following formula for calculating *EMP*:

$$EMP_t^{MD} = \Delta e_t + \eta^{MD} \Delta r_t \tag{1}$$

where Δe_t is the percentage change in the domestic currency cost of one unit of the foreign currency, Δr_t is the change in official foreign exchange reserves as a percentage of the one period lagged value of the money base and $\eta^{MD} = -\partial \Delta e_t / \partial \Delta r_t$, which has to be estimated from a structural model of the economy. The *MD* superscript refers to the fact that, as η is model-dependent, so too is the measure of *EMP*. Importantly, this formula is derived under the assumption that the central bank does not use domestic credit changes to influence the exchange rate. Weymark (1997) shows how to relax this assumption but the estimation procedure becomes much more complex.

The small open-economy model used by Spolander (1999) is summarised in equations (2) to (8).

$$\Delta m_t^d = \beta_0 + \Delta p_t + \beta_1 \Delta c_t - \beta_2 \Delta i_t \tag{2}$$

$$\Delta p_t = \alpha_0 + \alpha_1 \Delta p_t^* + \alpha_2 \Delta e_t \tag{3}$$

$$\Delta i_t = \Delta i_t^* + E_t(\Delta e_{t+1}) - \Delta e_t \tag{4}$$

$$\Delta m_t^s = \Delta d_t^a + (1-\lambda)\Delta r_t \tag{5}$$

$$\Delta r_t = -\overline{\rho}_t \Delta e_t \tag{6}$$

$$\Delta d_t^a = \gamma_0 + \Delta y_t^{trend} + (1-\gamma_1)\Delta p_t - \gamma_2 y_t^{gap} \tag{7}$$

$$\Delta m_t^d = \Delta m_t^s \tag{8}$$

Notationally, m_t is the natural logarithm of the stock of money (with superscripts d and s denoting demand and supply respectively), p_t is the natural logarithm of the domestic price level, c_t is the natural logarithm of real domestic income, i_t is the domestic short term interest rate, p_t^* is the natural logarithm of the foreign price level, e_t is the natural logarithm of the exchange rate expressed as units of domestic currency per unit of foreign currency, i_t^* is the foreign short term interest rate, d_t^a is autonomous domestic lending by the central bank divided by the one period lagged value of the money base (B_{t-1}), r_t is the stock of foreign exchange reserves divided by the one period lagged value of the money base (B_{t-1}), y_t^{trend} is the long-run trend component of real domestic output (y_t), and y_t^{gap} is the difference between y_t and y_t^{trend}.

In this model, it is assumed that agents form expectations rationally and also that a constant proportion (λ) of intervention is sterilized. Furthermore, under this model, the sterilized portion of intervention is ineffective. As empirical evidence (see Edison (1993) for a survey) is still mixed with regards to the efficacy of sterilized intervention, this is not an unreasonable assumption. Uncovered interest parity is assumed to hold, which rules out the existence of a portfolio balance effect, while future expectations about the exchange rate are held constant when imputing *EMP*, which eliminates the possibility of a signaling effect.

Equation (2) describes changes in money demand as a positive function of domestic inflation and changes in real domestic income and a negative function of changes in the domestic interest rate. Equation (3) describes the purchasing power parity condition where exchange rate changes and foreign inflation determine domestic inflation. Equation (4) describes uncovered interest rate parity. Equation (5) explains changes in the money supply as a positive function of autonomous changes in domestic lending and unsterilised changes in the stock of foreign exchange reserves. Equation (6) states that changes in foreign exchange reserves are a function of the exchange rate and a time-varying response coefficient, $\bar{\rho}_t$. Equation (7) describes the evolution of the central bank's domestic lending. It suggests that changes in domestic lending are a positive function of domestic inflation and changes in trend real output, and a negative function of the gap between real output and its trend. Equation (8) is a money market clearing condition that states that money demand is continuously equal to money supply.

By substituting equations (3) and (4) into equation (2), and substituting equation (7) into equation (5) and then using the money market clearing condition in equation (8) to set the resulting two equations equal to one another, it is possible to obtain the following relation:

$$\Delta e_t = \frac{X_t + \beta_2 E(\Delta e_{t+1}) + (1-\lambda)\Delta r_t}{\gamma_1 \alpha_2 + \beta_2} \tag{9}$$

where

$$X_t = \gamma_0 - \gamma_1 \alpha_0 - \beta_0 + \Delta y_t^{trend} - \gamma_1 \alpha_1 \Delta p_t^* - \gamma_2 y_t^{gap} - \beta_1 \Delta c_t + \beta_2 \Delta i_t^* \tag{10}$$

and the elasticity needed to calculate *EMP* in equation (1) can be found as

$$\eta^{MD} = -\partial \Delta e_t / \partial \Delta r_t = -\frac{(1-\lambda)}{\gamma_1 \alpha_2 + \beta_2} \tag{11}$$

In deriving equation (11) it is assumed that all of the variables in X_t are exogenous. Also, following Weymark (1995) and Spolander (1999), the expected exchange rate change is held constant while imputing *EMP*.

As an alternative to the above model-dependent approach, Eichengreen *et al* (1996) proposed the following model-independent measure of *EMP*:

$$EMP_t^{ERW} = \Delta e_t + \eta_1^{ERW} \Delta r_t + \eta_2^{ERW} \Delta i_t \tag{12}$$

where

$$\eta_1^{ERW} = -\sqrt{\frac{\text{var}(\Delta e_t)}{\text{var}(\Delta r_t)}}\ ,\ \eta_2^{ERW} = \sqrt{\frac{\text{var}(\Delta e_t)}{\text{var}(\Delta i_t)}}$$

and use has been made of the small open economy assumption that the larger foreign country does not change its interest rate or reserves to offset *EMP* on the bilateral exchange rate. It is also assumed that the policy authority relieves *EMP* through both reserve changes and interest rate changes. In the derivation of the model-dependent measure, it was assumed that the central bank did not alter domestic credit in order to affect the exchange rate. Accordingly, as changes in domestic credit drive changes in the domestic interest rate, the model-independent measure of *EMP* used in this paper does not include the change in the domestic interest rate:

$$EMP_t^{MI} = \Delta e_t + \eta^{MI} \Delta r_t \tag{13}$$

$$\eta^{MI} = -\sqrt{\frac{\text{var}(\Delta e_t)}{\text{var}(\Delta r_t)}} \tag{14}$$

The *EMP* formulas given for the model-dependent and model-independent approaches in equations (1) and (13) respectively are essentially identical. The difference between the two methods is the way in which η is calculated, as specified in equations (11) and (14). The *EMP* indices calculated from these formulas represent changes in the exchange rate that would have occurred if the Reserve Bank of Australia (RBA) had unexpectedly refrained from intervening in the foreign exchange market. Negative values indicate pressure for the Australian dollar to appreciate during that period, while positive values indicate pressure for the Australian dollar to depreciate.

Weymark (1995, 1998) proposed a degree of intervention (*DI*) index that measures the proportion of *EMP* relieved by intervention. For both the model-dependent and model-independent approaches, the *DI* index is calculated as

$$DI_t = \frac{\eta \Delta r_t}{EMP_t} \tag{15}$$

When $DI = 1$, the central bank intervenes to keep the exchange rate fixed, and when $DI = 0$, the central bank does not intervene, thus allowing the exchange rate to float freely. Negative values of *DI* indicate that intervention magnifies changes in the exchange rate. That is, when the exchange rate is under pressure to depreciate, intervention magnifies the depreciation. Values of *DI* between 0 and 1 indicate that intervention has acted to reduce the pressure on the exchange rate. When $DI > 1$, intervention reverses the exchange rate movement. That is, the exchange rate is induced to move in the opposite direction to the movement that would have occurred in the absence of foreign exchange intervention. Due to the discontinuity of the specification of equations used in defining the degree of intervention, *DI* can take extremely large absolute values.[2] Hence, extremely large values of *DI* will be replaced by 2 when $DI > 2$ and -1 when $DI < -1$.

4 Data Description

Quarterly measures of the data series were obtained for the period from 1984:1 to 2003:4. See Appendix A for a detailed description of the data series and their sources. Time series properties of each of the data series are reported in Appendix B. Unit root tests indicate that almost all of the variables are first difference stationary. The one exception is also found to be first difference stationary if the number of lags in the Augmented Dickey-Fuller test is increased. The first difference stationarity of the variables is what prompted Spolander (1999) to specify equations (2) and (3) in first differences.

The model is estimated for the bilateral Australian dollar against the US dollar exchange rate (e_t). The Australian 90-day bank-accepted bill rate is used as the domestic interest rate (i_t) and the 3-month US certificate of deposits rate represents the foreign interest rate (i_t^*). The M1 monetary aggregate is used as the domestic money stock (m_t). The Australian and US consumer price indices proxy for the domestic price level (p_t) and the foreign price level (p_t^*) respectively. Australian and US real gross domestic product represent the domestic level of output (y_t) and the foreign level of output (y_t^*) respectively. Australian real gross national income is used as the domestic national income (c_t). The Australian money base (B_t) and a measure of net spot foreign exchange transactions (ΔR_t), are also used in estimation. The measure of foreign exchange transactions includes transactions between the RBA and market participants as well as transactions between the RBA and the Australian government.

5 Empirical Analysis and Results

It is clear from equation (11) that in order to calculate *EMP* using the model-dependent formula, it is necessary to obtain estimates of four parameters in the model - λ, γ_1, α_2 and β_2. The parameter estimates are obtained by estimating the following three equations:

$$\Delta m_t - \Delta p_t = \beta_0 + \beta_1 \Delta c_t + \beta_2 \Delta i_t + \varepsilon_{1,t} \tag{16}$$

$$\Delta p_t = \alpha_0 + \alpha_1 \Delta p_t^* + \alpha_2 \Delta e_t + \varepsilon_{2,t} \tag{17}$$

$$\frac{\Delta B_t}{B_{t-1}} - \Delta r_t - \Delta y_t^{trend} - \Delta p_t = \gamma_0 + \lambda\ \Delta r_t + \gamma_1 \Delta p_t + \gamma_2 y_t^{gap} + \varepsilon_{3,t} \tag{18}$$

Equations (16) and (17) are obtained directly from equations (2) and (3). Equation (18) is obtained by substituting equation (7) into equation (5) and by noting that $\frac{\Delta B_t}{B_{t-1}}$ represents the change in the money supply scaled by the one period lagged value of the money supply under the assumption of a constant money multiplier. From the equations used to derive equations (16), (17) and (18) it can be observed that β_1, α_1, and α_2 should be positive and that β_2, γ_1, γ_2, and λ should be negative. Furthermore, as λ is a fraction, its absolute value should be between zero and one.

As the equations have endogenous variables on the right hand side, they were estimated using a two-stage least squares approach. Instrumental variables for the two-stage regressions were chosen by considering all of the exogenous variables and the one period lag of all of the endogenous and exogenous variables as possible instruments, and selecting significant variables from initial regressions of each endogenous variables on the possible instruments. Two-stage least squares was used in preference to three-stage least squares or full information maximum likelihood estimation due to its greater robustness in the presence of misspecification and the relatively small sample size.

The two-stage least squares estimation results are provided in Table 1. All of the parameters are correctly signed and most are significant. However, a few of the parameters in equation (18) are statistically insignificant. This is in line with Spolander's findings and he attributed the problem to misspecification of the relationship governing the evolution of domestic lending. The α_2 parameter in equation (17) is also statistically insignificant.

Diagnostic tests for each equation are also included in Table 1. The tests suggest that the residuals from equation (17) are autocorrelated and therefore the standard errors for this equation are corrected using the Newey-West procedure. Furthermore, the residuals from all three equations are non-normally distributed. This means that the *t*-tests of statistical significance in Tables 1 may be misleading. However, this does not reduce the validity of the parameter estimates.

< Insert Table 1 here >

The two *EMP* indices are presented in the first two columns of Appendix C, while the two *DI* indices constructed from the *EMP* indices are presented in the last two columns. A speech by Ian Macfarlane (then Deputy Governor of the RBA) published in the RBA Bulletin in 1993, gives some insight into a number of intervention episodes in the period of 1985-1991. This provides some basis against which to compare the estimated indices. The two *EMP* indices are reasonably plausible and follow a fairly similar pattern, although the model-dependent measure displays more volatility.

Both *EMP* indices suggest that between 1984:1 and 1986:3, the Australian dollar was generally under pressure to depreciate. The *DI* indices indicate that, at least at the beginning of this period, the RBA seemed content to let the Australian dollar depreciate as significant depreciation pressure in 1984:2, 1985:1 and 1985:2 was offset by intervention only to a small degree, and depreciation pressure in 1984:3 was actually very slightly exacerbated by intervention. By mid 1986, the Australian dollar was down to around the US$0.60/A$ mark, and Macfarlane (1993) suggests that at this point the RBA started to feel that the Australian dollar was becoming undervalued, and, consequently, the RBA intervened quite heavily during 1986:3 in support of the Australian dollar. Under the model dependent *EMP* index, the

Australian dollar was under pressure to depreciate by 16.7% during this quarter, which was offset to a reasonably substantial degree by RBA intervention.

The *EMP* indices indicate that the Australian dollar rebounded quite strongly from late 1986 through to late 1988, to such an extent that the *DI* indices suggest that the RBA actually intervened very substantially to smooth the upward progress of the Australian dollar during this time. Two important exceptions during this period of pressure on the Australian dollar to appreciate were 1987:1 and 1987:4. The second of these anomalies is due to the global stock market crash. Macfarlane (1993) suggests that in both of these periods the RBA intervened heavily in support of the dollar, and this is borne out by the *DI* indices.

By late 1988, Macfarlane (1993) suggests that the RBA was starting to feel that the Australian dollar was becoming overvalued as it neared the US$0.90/A$ level. From 1989:1 to 1989:3 the RBA was content to let the Australian dollar depreciate, as intervention only slightly offset depreciation pressure in the first two quarters and reversed appreciation pressure in the third quarter. Macfarlane (1993) also suggests that appreciation pressure was offset to a significant degree in the December quarter of 1990 and the June quarter of 1991, and this is borne out by the *DI* indices. However, the *EMP* values for these quarters suggest that the pressure to appreciate was not very substantial in these quarters.

The model-dependent *DI* index tells an interesting story about the recent history of the Australian dollar. From 1997:1 until 1998:3 the Australian dollar faced pressure to depreciate, which was exacerbated in 4 of the 7 quarters by RBA intervention. Then in 1999:4, 2000:4

and 2001:2 the RBA intervened to reverse sizable pressure on the Australian dollar to appreciate. As such, this provides some evidence that the RBA may be at least partly responsible for the fall of the Australian dollar from about US$0.80 per A$ at the end of 1996 to around US$0.50 per A$ by mid 2001. The model-independent *DI* index displays the same overall pattern but much less strongly.

A number of limitations have to be considered when interpreting the results of this analysis. First, two of the parameter estimates needed for the construction of the model-dependent *EMP* index are insignificantly different from zero. This suggests that there is a problem either with the model specification or with the estimation procedure, and casts doubt on the accuracy of the model-dependent *EMP* index. Second, the parameter estimates are quite sensitive to the choice of instrumental variables, and small changes in the parameter estimates have a large impact on the *EMP* values. Third, the Spolander model does not allow for sterilized intervention having any effect. As the sterilization parameter (λ) is insignificantly different from one (fully sterilized intervention), it would be worthwhile in future to extend the model to allow sterilized intervention to have an impact on the exchange rate. Finally, both of the *EMP* indices used in this paper were derived under the assumption that changes in domestic lending (or the domestic interest rate) are not used to affect the exchange rate. However, there have been times where the RBA has acknowledged that the state of the exchange rate has played some part in determining its monetary policy stance. As such, another possible future extension of this work is to allow for indirect intervention operating through changes in domestic lending or the domestic interest rate.

6 Conclusion

This paper estimates exchange market pressure (*EMP*) indices for the Australian dollar against the US dollar exchange rate over the Australian post-float period using a model-dependent approach proposed by Weymark (1995, 1998) and a model-independent approach developed by Eichengreen, Rose and Wyplosz (1996). Although there are some concerns in the estimation of the model-dependent index, both indices appear to provide reasonably plausible descriptions of the pressure on the Australian dollar. Degree of intervention (*DI*) indices are also constructed. The results suggest that the Reserve Bank of Australia (RBA) contributed to the large depreciation of the Australian dollar between 1997 and 2001. In general, there is some evidence to suggest that over this period, RBA intervention magnified pressure for the Australian dollar to depreciate and reversed pressure for the dollar to appreciate.

NOTES

1 See, for example, Modeste (1981) for Argentina; Kim (1985) for Korea; Hacche and Townend (1981) for the United Kingdom; Burdekin and Burkett (1990) for Canada; and Connolly and da Silveira (1979) for Brazil.

2 See Spolander (1999:83) for a detailed discussion of this problem.

Table 1: Estimates of Equations (16), (17) and (18) using Two-Stage Least Squares

	Estimate	*t*-statistics		
Equation 16:				
Instrument List: (Δp_t^*) (Δi_t^*) (Δc_t) (Δi_{t-1})				
β_0	0.000	0.069 (0.945)	J-B:	31.225 (0.000)
β_1	1.514	1.940 (0.056)	ARCH:	1.727 (0.786)
β_2	-0.013	-2.047 (0.044)	LM:	5.892 (0.207)
Equation 17:				
Instrument List: (Δp_t^*) (Δi_t^*) (Δc_t) (Δy_t^{trend})				
α_0	0.002	1.405 (0.164)	J-B:	6.460 (0.040)
α_1	0.653	1.887 (0.063)	ARCH:	3.893 (0.421)
α_2	0.079	1.036 (0.303)	LM:	21.018 (0.000)
Equation 18:				
Instrument List: (Δp_t^*) (Δi_t^*) (Δi_{t-1}) (Δp_{t-1}) (Δr_{t-1}) (y_t^{gap})				
γ_0	0.013	1.194 (0.236)	J-B:	461.046 (0.000)
γ_1	-0.854	-0.351 (0.727)	ARCH:	0.689 (0.953)
γ_2	-0.166	-0.147 (0.884)	LM:	3.317 (0.535)
λ	-0.962	-9.931 (0.000)		

Jarque-Bera (J-B); Lagrange multiplier (ARCH); Breusch-Godfrey Lagrange Multipler (LM). Probability values in parenthesis. All ARCH and LM tests are run with 4 lags.

APPENDIX A: The Data

Quarterly measures of the data series were collected over the period 1984:1 to 2003:4.

e_t Australian dollar exchange rate against the US dollar

Obtained from RBA Bulletin Table F11, inverted to express as AUD per USD, converted from monthly to quarterly data by averaging the three monthly figures and then logged.

m_t Australian M1 monetary aggregate

Obtained in seasonally adjusted form from RBA Bulletin Table D03, converted from monthly to quarterly data by averaging the three monthly figures and then logged.

i_t^* The US 3-month certificate of deposits rate

Obtained from Federal Reserve Statistical Table H.15 and then converted from monthly to quarterly data by averaging the three monthly figures.

i_t Australian 90-day bank-accepted bill rate

Obtained from RBA Bulletin Table F01 and then converted from monthly to quarterly data by averaging the three monthly figures.

p_t Australian consumer price index

Obtained from Australian Bureau of Statistics Publication 6401.0 Table 1b and then logged. The base period is 1989-1990.

p_t^* The US consumer price index

Obtained from the Bureau of Labour Statistics, Series CUUR0000SA0, converted from monthly to quarterly data by averaging the three monthly figures and then logged. The base period is 1982-1984.

y_t Australian real gross domestic product

Obtained from RBA Bulletin Table G10 and then logged.

y_t^{trend} Long-run trend component of y_t

Obtained using the Hodrick-Prescott filter and a smoothing parameter of 1600, as recommended for quarterly data.

c_t Australian gross national income

Obtained from RBA Bulletin Table G10 and then logged.

B_t Australian money base

Obtained from RBA Bulletin Table D03, converted from monthly to quarterly data by averaging the three monthly figures and then logged.

ΔR_t Total foreign exchange transactions by the RBA

Obtained from RBA Bulletin Table A04, converted from monthly to quarterly data by summing the three monthly figures and then logged.

APPENDIX B: Augmented Dickey-Fuller Unit Root Tests

Series (1983:4-2003:4)	Test Statistic for Level	Test Statistic for First Difference
e_t	-2.383	-3.343*
m_t	-1.486	-4.563*
i_t	-1.489	-3.398*
i_t^*	-2.336	-4.423*
p_t	-3.146	-3.679*
p_t^*	-0.204	-2.801***
y_t^{trend}	-0.949	-1.697
y_t^{gap}	-3.402**	-4.962*
c_t	-2.070	-3.774*
$\Delta B_t / B_{t-1}$	-4.048*	
Δr_t	-5.036*	

All tests are run with 2 lags. ***, ** and * denote the rejection of the null hypothesis of a unit root at the 10, 5 and 1 percent significance levels respectively. For the level tests m_t , p_t , p_t^*, y_t^{trend} and c_t were run with a trend and a constant, while e_t i_t i_t^* y_t^{gap} were run with just a constant. For the first difference tests m_t , p_t , p_t^*, y_t^{trend} and c_t were run with a constant, while e_t , i_t , i_t^* y_t^{gap}, $\Delta B_t / B_{t-1}$ and Δr_t were run with neither a trend nor a constant.

APPENDIX C: Estimates of the *EMP* and *DI* indices

	EMP^{MD}	EMP^{MI}	DI^{MD}	DI^{MI}
Mar-84	0.026	0.004	1.389	**2**
Jun-84	0.045	0.029	0.591	0.361
Sep-84	0.025	0.027	-0.127	-0.046
Dec-84	0.004	-0.001	**2**	**-1**
Mar-85	0.092	0.070	0.380	0.193
Jun-85	0.076	0.061	0.325	0.158
Sep-85	-0.003	-0.022	**-1**	-0.565
Dec-85	0.058	0.032	0.743	0.530
Mar-86	-0.031	-0.020	0.583	0.353
Jun-86	0.027	0.010	1.012	1.032
Sep-86	0.167	0.105	0.610	0.379
Dec-86	-0.174	-0.085	0.839	0.670
Mar-87	0.036	0.003	1.506	**2**
Jun-87	-0.147	-0.070	0.860	0.706
Sep-87	-0.061	-0.022	1.032	1.085
Dec-87	0.124	0.052	0.954	0.891
Mar-88	-0.048	-0.027	0.702	0.479
Jun-88	-0.177	-0.091	0.800	0.610
Sep-88	-0.030	-0.016	0.768	0.564
Dec-88	-0.041	-0.033	0.294	0.140
Mar-89	0.016	0.012	0.430	0.228
Jun-89	0.039	0.038	0.034	0.013
Sep-89	-0.019	-0.007	1.010	1.026
Dec-89	-0.024	-0.016	0.501	0.281
Mar-90	0.037	0.023	0.626	0.395
Jun-90	-0.057	-0.025	0.921	0.820
Sep-90	-0.025	-0.023	0.081	0.033
Dec-90	-0.011	0.007	**2**	**-1**

APPENDIX C (Cont.): Estimates of the *EMP* and *DI* indices

	EMP^{MD}	EMP^{MI}	DI^{MD}	DI^{MI}
Mar-91	0.000	-0.001	**2**	-0.786
Jun-91	-0.003	0.003	**2**	**-1**
Sep-91	-0.008	-0.009	-0.177	-0.062
Dec-91	0.022	0.012	0.710	0.488
Mar-92	0.080	0.038	0.870	0.723
Jun-92	0.013	0.006	0.914	0.806
Sep-92	0.077	0.042	0.757	0.549
Dec-92	0.040	0.029	0.458	0.248
Mar-93	0.024	0.007	1.124	1.393
Jun-93	-0.003	0.001	**2**	**-1**
Sep-93	-0.003	0.007	**2**	-0.969
Dec-93	-0.001	0.000	1.438	**2**
Mar-94	-0.022	-0.026	-0.287	-0.095
Jun-94	-0.021	-0.014	0.552	0.325
Sep-94	0.003	-0.004	**2**	**-1**
Dec-94	0.007	-0.005	**2**	**-1**
Mar-95	0.001	0.007	**-1**	-0.557
Jun-95	0.035	0.023	0.588	0.358
Sep-95	-0.012	-0.016	-0.495	-0.148
Dec-95	-0.026	-0.011	0.983	0.958
Mar-96	0.020	0.003	1.370	**2**
Jun-96	-0.040	-0.025	0.598	0.367
Sep-96	-0.054	-0.019	1.056	1.158
Dec-96	-0.012	-0.010	0.363	0.182
Mar-97	0.005	0.010	**-1**	-0.319
Jun-97	0.013	0.009	0.469	0.256
Sep-97	0.013	0.015	-0.333	-0.108
Dec-97	0.018	0.028	-0.855	-0.219

APPENDIX C (Cont.): Estimates of the *EMP* and *DI* indices

	EMP^{MD}	EMP^{MI}	DI^{MD}	DI^{MI}
Mar-98	0.059	0.027	0.900	0.778
Jun-98	0.012	0.021	**-1**	-0.274
Sep-98	0.056	0.038	0.525	0.301
Dec-98	-0.041	-0.030	0.430	0.227
Mar-99	-0.001	-0.001	**-1**	-0.362
Jun-99	-0.039	-0.027	0.486	0.270
Sep-99	0.032	0.016	0.827	0.650
Dec-99	-0.194	-0.075	1.009	1.022
Mar-00	0.153	0.071	0.882	0.744
Jun-00	0.000	0.014	**-1**	-0.626
Sep-00	0.028	0.021	0.436	0.232
Dec-00	-0.074	-0.011	1.388	**2**
Mar-01	0.027	0.016	0.667	0.439
Jun-01	-0.064	-0.020	1.137	1.445
Sep-01	0.023	0.008	1.031	1.084
Dec-01	-0.006	-0.003	0.664	0.436
Mar-02	0.034	0.010	1.162	1.557
Jun-02	-0.076	-0.049	0.589	0.358
Sep-02	0.021	0.012	0.664	0.435
Dec-02	-0.017	-0.013	0.464	0.253
Mar-03	0.018	-0.011	**2**	**-1**
Jun-03	-0.161	-0.083	0.793	0.599
Sep-03	-0.001	-0.004	**-1**	-0.554
Dec-03	-0.101	-0.065	0.582	0.352

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All correspondence to:

Associate Professor Andrew C Worthington
Editor, *Discussion Papers in Economic, Finance and International Competitiveness*
School of Economics and Finance
Queensland University of Technology
GPO Box 2434, BRISBANE QLD 4001, Australia

Telephone: 61 7 3864 2658
Facsimile: 61 7 3864 1500
Email: a.worthington@qut.edu.au

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